Project Title:
Alternative production systems for landscape nursery production

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Summary
In the fall of 2005 and spring of 2006 we established a Pot-in-pot research site at the Michigan State University Horticulture Teaching and Research Center. The goal of the project is to investigate the growth and physiology of landscape trees in Pot-in-pot production. We established and began data collection on two studies: 1) Landscape shade trees and 2) Landscape conifers.

Background
Pot-in-pot growing systems are a rapidly expanding technology for the production of landscape trees. In pot-in-pot systems, trees are grown in containers that are placed in a second, slightly larger 'socket' pot in the ground. Pot-in-pot systems provide several advantages to growers and customers. Growing trees in containers above ground in Michigan can be difficult because of blow-over in high winds. Also, roots of containerized trees grown above-ground may be injured by severe cold during the winter unless the roots are protected with mulch or other materials. Pot-in-pot production eliminates the common problems of blow-over and winter root protection and also modifies pot and root temperature during the summer (Martin et al. 1999) and can improve total growth and root growth (Ruter 1993, 1998a, 1998b).

In Michigan, several nurseries have installed Pot-in-pot growing systems for landscape shade trees and conifers for landscape use or use as living Christmas trees. Unfortunately, much of the literature on pot-in-pot production is based on research on the southern U.S. In order to improve the efficiency of Pot-in-pot systems for Michigan we need to develop species-specific recommendations for fertilization and nutrient management and container media selection.

Landscape shade trees
We installed 160 25-gallon socket pots at the MSU Horticulture Teaching and Research Center in the spring of 2006 (Fig. 1). We planted 20 trees from each of eight species (Table 1). The trees were planted in 25 gallon containers in a standard container media (80% pine bark: 20% peat moss). The trees were all planted as 1" to 1 ½" bare root liners. Trees were watered 2-3 times weekly via an overhead irrigation system. Initial survival and budbreak of all species was near 100% except for the hackberry trees, which had substantial die-back. The cause of the hackberry dieback is unknown but is very common in bare-root transplants of this species (personal communication, Keith Warren, J. Frank Schmidt and Son Nursery).

We initiated a study of the response of the landscape trees to varying rates of fertilization. In May 2006 we applied four fertilizer levels to 5 trees of each species using a controlled release fertilizer (Osmocote Plus 15-9-12, Scotts, Inc.). Fertilizer was applied at a rates ranging from ½ to 2 times the manufacturer's recommended rates (100, 200, 300 or 400 grams per container). Initial heights and diameters were measured on all trees. We are re-measuring growth monthly.

In order to compare species and nutrient effects on tree physiology we began bi-weekly physiology measurements in June 2006 (Fig. 2). We measured photosynthetic gas exchange with a portable photosynthesis system (LI-6400, Li-Cor, Inc., Lincoln, NE). Leaf spectral reflectance, an indicator of leaf chlorophyll concentration, was measured with a SPAD meter (Minolta, Inc). Efficiency of light capture in photosynthesis was estimated by variable chlorophyll fluorescence measured with a portable fluorometer (Hansatech, Ltd.)

Initial measures of maximum photosynthetic rate indicate that species vary widely in their photosynthetic capacity. (Fig. 3). The maple cultivars and the elm cultivars had relatively high photosynthetic rates compared to the other species. Photosynthetic rates did not differ among nutrition levels, reflecting the relatively short time the treatments had been applied. We expect nutrition effects will be more important over time.

In addition to the physiology measurements we are collecting bi-weekly samples of leachate water from a sub-sample of trees for nitrate analysis beginning in June 2006. We removed the trees from their socket pot and watered to run-off. The trees were then placed in a large plastic basin and an additional 2 liters of water was added to the container. A sample of the resulting run-off was captured, tested for pH and conductivity, and sent to the MSU Soil and Plan Analysis laboratory for nitrate analysis.

Table 1.Tree species installed in the MSU Pot-in-Pot research trial

Scientific name	**Common name**	**Michigan Native**
Celtis occidentalis	Hackberry	Yes
Acer rubrum	Red maple	Yes
Liriodendron tulipifera	Tulip Poplar	Yes
Quercus rubra	Red Oak	Yes
Acer freemanii	Fremani maple	No
Plantanus x acerifolia	Bloodgood Planetree	No
Ulums 'Accolade'	Accolade Elm	No
Ulmus 'Triumph'	Triumph Elm	No

Landscape Conifer/Living Christmas tree study

We planted one hundred conifer transplants (plug + 2 or 2 + 2) from each of four species (Colorado blue spruce, Eastern white pine, Black hills spruce and Fraser fir) in 3 gallon containers (Fig. 4). The trees were planted in one of three pine bark: peat container media mixes (90:10, 80:20, or 70:30) (Renewed Earth, Inc.). The trees were top-dressed with a controlled release fertilizer (Osmocote Plus 15-9-12, Scotts, Inc) at ½ X, 1 X, or 2X the manufacturer's recommended rate (18, 38, or 75 grams per container). We measured initial height and caliper on all trees after planting. We are re-measuring growth on a monthly basis.

Two months after transplanting initial survival of all pines and spruces was 100%. Ten of the Fraser fir developed symptoms of Phytophthora root rot (subsequently confirmed by the MSU Diagnostics laboratory) and were removed from the study. The remaining Fraser fir trees were treated with a systemic fungicide (Subdue Maxx) at the labeled rate.

We completed an initial set of photosynthetic gas exchange measurements on the pines using 1-year-old needles. We will begin gas exchange and physiology measurements on the remaining conifers once they have completed this year's growth flush. We will measure gas exchange and variable chlorophyll fluorescence bi-weekly during the growing season.

We initiated collection of container leachate on the pine trees and Fraser fir trees. Collection procedures were similar to those described for the landscape trees. We will continue sample collection on a bi-weekly basis.

Figure 1. Installing socket pots for 25-gallon gallon containers using a 24" auger.

Figure 2. MSU Graduate Research Assistant Wendy Klooster measures photosynthetic capacity of Triumph elms in the MSU Pot-in-pot research trial

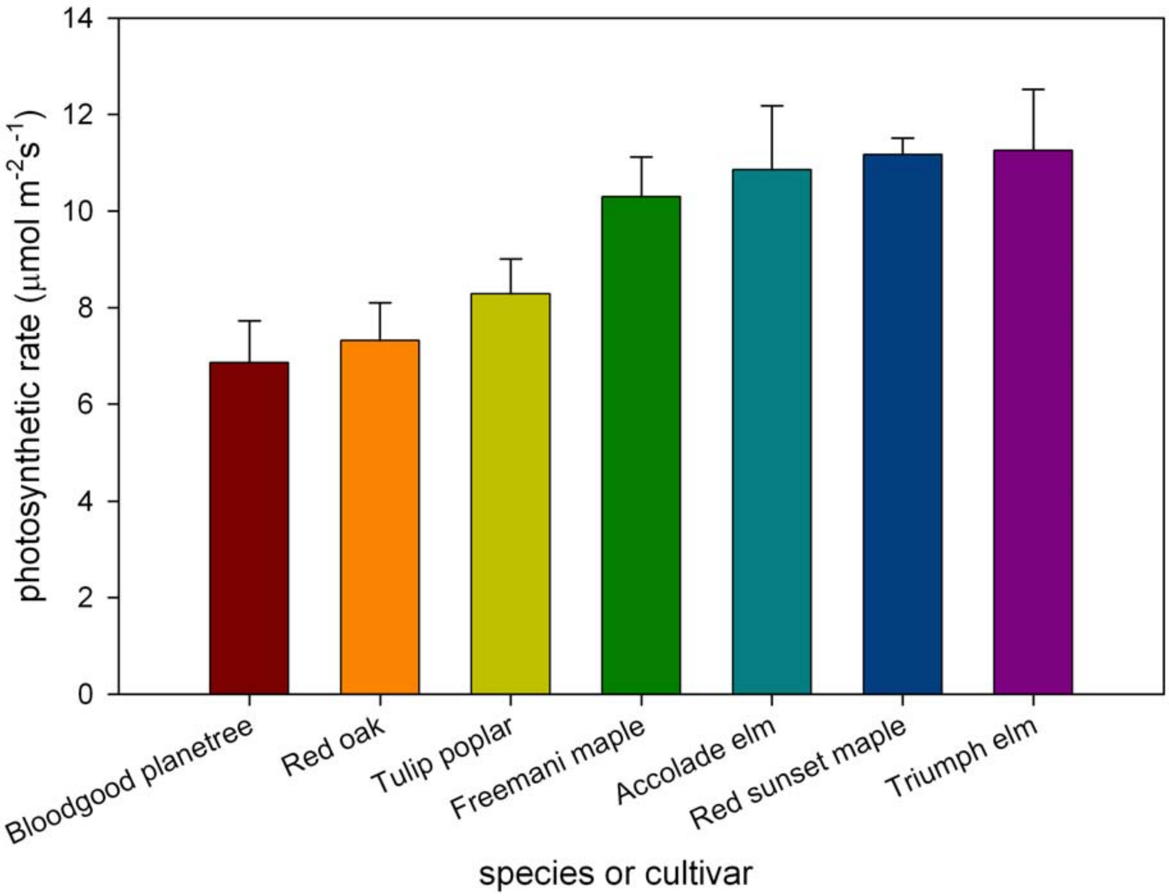

Figure 3. Phtosynthetic capacity of seven landscape tree cultivars grown at MSU Pot-in-pot research trial, June 30, 2006.


Figure 4. Landscape conifers/Living Christmas trees installed at MSU Pot-in-Pot research site.

Measurements 2006

During the 2006 growing season we will continue to monitor growth and physiological responses of the trees to fertilization and container substrate. We will measure height and diameter growth monthly. We will collect foliar nutrient samples in August (shade trees) and October (conifers). Net photosynthesis and chlorophyll fluorescence will be measured every two weeks during the growing season. Leachate will be sampled every two weeks for nitrate, pH, and conductivity. We will net a sub-sample of trees in the landscape tree trial and collect litterfall in order to estimate tree leaf biomass and tree leaf area.

Acknowledgments In addition to support from the MDA Horticulture fund we gratefully acknowledge support from:

MSU Project GREEEN
Michigan Nursery and Landscape Association
Michigan Forestry and Parks Association
Michigan Christmas Tree Association
Nursery Supplies, Inc.
J. Frank Schmidt and Sons Nursery
Renewed Earth, Inc.
Scotts, Inc,
Petersons Riverview Nursery
Faiplain Nursery
MSU Grounds Department